Exemption No. 6086

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
RENTON, WASHINGTON 98055-4056

In the matter of the petition of **Boeing Commercial Airplane Group** for an exemption from § 25.1435(b)(1) of the Federal Aviation Regulations	**Regulatory Docket No. 28096**

GRANT OF EXEMPTION

By letter of January 18, 1995, Mr. K.K. Usui, Manager, Next-Generation 737 Certification, Boeing Commercial Airplane Group, P.O. Box 3707, Seattle, WA, 98124-2207, petitioned for exemption from the static pressure test requirement of § 25.1435(b)(1) of the Federal Aviation Regulations (FAR), for the hydraulic system on the Boeing Model 737-700 airplane. By letter of February 7, 1995, Mr. Usui provided clarifying and additional information in support of the same petition for exemption.

Section of the FAR affected:

> Section 25.1435(b)(1) states that a complete hydraulic system must be static tested to show that it can withstand 1.5 times the design operating pressure without a deformation of any part of the system that would prevent it from performing its intended function. Clearance between structural members and hydraulic system elements must be adequate, and there must be no permanent detrimental deformation. For the purpose of this test, the pressure relief valve may be made inoperable to permit application of the required pressure.

ANM-95-013-E

Related Section of the FAR:

Section 25.1435(a)(2) states that each element of the hydraulic system must be able to withstand, without rupture, the design operating pressure loads multiplied by a factor of 1.5, in combination with ultimate structural loads that can reasonably occur simultaneously. Design operating pressure is maximum normal operating pressure, excluding transient pressure.

The petitioner's supportive information is as follows:

In place of the static test (4500 psi), Boeing proposes to demonstrate compliance with the intent of § 25.1435(b)(1) by a combination of a range-of-motion test of the complete hydraulic system at 3400 psig and component testing at 1.5 times operating pressure (4500 psi) per § 25.1435(a)(2).

Boeing states that the operating characteristics of the 10-60551 relief valves used in the 737-700 hydraulic system are defined in the specification control drawing (SCD) at two pressures (rated flow and reseat). Use of 3400 psi during the hydraulic system range of motion test is proposed because it is the minimum allowed SCD reseat pressure for the A, B, and Standby hydraulic system relief valves. Use of 3400 psi ensures that the hydraulic system relief valves remain seated during static operation of the system and that valve reseat will occur after range of motion cycling where pressure transients may cause the relief valve cracking. It is considered that 3400 psi is just below the relief valve cracking pressure.

Boeing asserts that the granting of this exemption with respect to testing a complete hydraulic system at 1.5 times operating pressure is in the public interest because the proposed method of demonstrating compliance will provide greater assurance of airplane safety than that required by § 25.1435(b)(1).

Boeing provides the following factors to substantiate their position that this petition for exemption not only provides for an equal or greater level of safety, but eliminates inefficiencies and added cost as well.

Purpose of § 25.1435(b)(1), Pressure Test/Measured Deflections.

The purpose of § 25.1435(b)(1) is to show adequate separation between hydraulic system elements and structure and that there will be no permanent detrimental deformation that would prevent the system from performing its intended function. To ensure hydraulic system integrity and no contact between hydraulic lines, structure, or surrounding systems, Boeing's design &

installation practice is to maintain a minimum 0.25 inch clearance envelope (in excess of expected motion) around all tubing and hoses.

Additionally, Boeing has concluded from pressure testing in the Flight Controls Test Rig (FCTR), that tubing deflections due to pressurization are so minimal that testing at 4500 psig provides no perceivable benefits. In fact, the pressure testing reveals that without instrumentation, it is difficult, if not impossible, to tell that the tubing has deflected. Measured deflections were 0 to 0.0065 inches, which Boeing considers to be well within the 0.25 inch clearance envelope (Note: FCTR figures/photographs and a plot of measured deflections from three separate test setups were submitted as substantiating data).

Improved Design Processes.

On the 737-700 program, Boeing has used improved processes and contemporary plumbing technology to assure an accurate initial installation with proven hydraulic components. The 737-700 program follows the lead of the 777 with early and frequent reviews of hydraulic installations and space allocations. Digital PreAssembly (DPA) buy-off process provides a means for all affected design disciplines to rectify interferences to avoid costly late changes in the design after release. "Fly-through" meetings allow all affected groups to study three-dimensional models in detail to ensure that the design meets all requirements. The 737-300 will have the most accurate tubing installations of any Boeing 737 model airplane to date.

Present Test Method.

Boeing states that at present, only pressure lines are tested. The 4500 psig static test is accomplished by disabling all of the pressure relief valves and disconnecting components which would overstress structure when pressurized to 4500 psi. The system is then pressurized to 4500 psig and inspected. The pressure is removed and the system modifications are removed to return the airplane to its original configuration. The greatest deficiency of the 4500 psig test method is its static nature. Normal operation of the hydraulic system is impossible, and transient effects, relative motion, and system interaction cannot be seen. Boeing further asserts that the associated paperwork and added cost (work and rework), without any added benefit, make the present test inefficient and non-value added.

Proposed Test Method, Including Component Testing

The 3400 psig test proposed by Boeing would test the complete system under operating conditions that more closely simulate service conditions. Before pressurizing the system, tubing would be inspected and areas of tight clearance noted. 3400 psi would be applied to the pressure system and the return lines would be pressurized to near-normal operating pressures

by movement of the control surfaces. The system pressure and return lines would then be observed with this pressure applied and the surfaces motionless, with special attention being paid to the above-noted areas. The primary flight controls, flaps and slats, spoilers, landing gear, brakes, nosewheel steering, and thrust reversers would then be cycled in turn while hose and tubing clearances were inspected.

Boeing asserts that this test method will provide a more complete view (greater level of safety) of system operation when compared to the semi-static or completely static 4500 psig test. The proposed test would be more efficient, involving minimal change to the airplane hydraulic system and minimizing rework expense.

Boeing further states that the static proof pressure testing will be conducted at 4500 psig, on all components subject to 3000 psig operation, during component qualification testing.

FAR/JAR Harmonization

Boeing notes that the proposed test is in complete agreement with the latest draft version of the proposed harmonized § 25.1435 test requirement (Reference: FAR/JAR 25.1435 Harmonization Working Group), an indication that this test has achieved general acceptance within the aviation community. Further, this method of test was approved by the FAA and the JAA for use on the Boeing 777 certification program.

In view of the substantiating factors detailed above, Boeing asserts that its proposed method of pressure testing of the complete hydraulic system of the 737-700 airplane is in the public interest, as it provides greater assurance of safe operation and does not impose inefficiencies and added cost (work and rework) associated with the static pressure test defined in § 25.1435(b)(1) and hereby petitions the FAA to grant the subject exemption.

A summary of the petition was published in the Federal Register on March 23, 1995 (56 FR 15320). No comments were received.

The Federal Aviation Administration's analysis/summary is as follows:

The FAA has carefully considered the information provided by the petitioner, and has determined that there is sufficient merit to warrant a grant of exemption.

Purpose of § 25.1435(b)(1).

The FAA concurs that the purpose of § 25.1435(b)(1) is as stated by the applicant. While the tubing deflection tests conducted by the applicant on its FCTR test setup are not exhaustive,

they are a quantitative indicator of the expected deflections and thereby required separation between components. In this regard, the applicant's design and installation requirements to ensure adequate clearance are satisfactory.

Improved Design Processes.

Even with improved design processes, errors are possible. The pressure test is intended to identify problems related to possible errors in the design process. Therefore, the FAA does not concur that improved processes provide a level of safety equivalent to testing at the required pressure. However, the FAA concurs that the DPA buy-off checks process instituted by the applicant is a contributing factor to ensure compliance to an acceptable level of safety.

Present Test Method.

Section 25.1435(b)(1) acknowledges the existence of and the need to deactivate relief valves in the hydraulic systems during proof pressure tests. The FAA concurs that due to deactivation of various components, the hydraulic systems are out of configuration during the test, additional paperwork is required, and added cost is incurred.

Proposed Test Method.

The FAA concedes that the proposed dynamic test (with nothing disabled) may be a better test than the required static test, and that it may meet the intent of the rule at an acceptable level of safety, provided it is run at or near the relief valve setting (3400 psig), and in combination with the component qualification tests.

FAR/JAR Harmonization

The FAA concurs that the proposed test is in compliance with the proposed harmonized rule change under consideration by the FAA and the JAA.

In consideration of the foregoing, I find that a grant of exemption is in the public interest. Therefore, pursuant to the authority contained in §§ 313(a) and 601(c) of the Federal Aviation Act of 1958, delegated to me by the Administrator (14 CFR 11.53), the Boeing Commercial Airplane Group is hereby granted an exemption from § 25.1435(b)(1) of the FAR to the extent necessary to permit type certification of the Model 737-700 by testing of the complete hydraulic system at 3400 psig, the system relief pressure. All test results pertinent to this exemption must be documented in a report and a copy provided to this office.

Issued in Renton, Washington, on May 17, 1995.

Darrell M. Pederson
Acting Manager
Transport Airplane Directorate
Aircraft Certification Service, ANM-100